Senate ... Committee
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SB 226

Costs of Small-Scale Energy Projects

Here is some information I received from our Demand Side Management Program people in Butte.

Small-Scale Solar PV –

A small-scale grid-tie solar PV system costs approximately $8.50/watt. The average capacity factor for solar PV in Montana is approximately 15%. A 2 kW grid-tie solar PV system costs about $17,000 and will generate about 2,600 kWh/yr (when new). The life of a solar PV system is 25 to 30 years; the output of the solar system decreases with time. When considering the life of the panels and the depreciated output over time, the cost of energy generated using solar PV is about $0.24/kWh. It would take approximately a 6 kW solar PV system with an installed cost of $50,000 to generate enough power for our "average" residential customer.

If you incorporate lead acid battery storage with a solar PV system, the cost of small-scale solar PV increases to about $12/watt. Also, some energy is lost in charging the batteries. The life of these batteries is about 7 years. When including battery storage costs, the cost for solar PV is $0.40/kWh to $0.50/kWh (depending on discount rates used, etc.).

Medium-Scale Solar PV –

The installed cost for a grid-tie medium-scale solar PV system (50 to 100 kW) is about $6.50 to $7.00 per watt. Everything else stays the same in terms of capacity factor, life, and decreased output over time. The energy generated for a medium-scale facility would run $0.18/kWh to $0.20/kWh.

Lead-acid batteries are not likely to be a feasible storage system with a system of this size given the cost, safety and environmental issues, especially the out-gassing hydrogen-sulfide gas.

Large-Scale Solar PV –

There have been a number of large-scale PV systems that have been installed in California, however, it is difficult to draw a comparison. Also, the latitudes of California and Arizona are better suited for PV generation (the capacity factor is higher). A one-megawatt plant in Montana would cost $5.00 to $5.50 per watt.

Small-Scale Wind –

The cost for small-scale wind is running about $4.00 to $4.50 per watt. The capacity factor for small-scale wind ranges from about 4% to 12% depending on the location of the turbine and the height of the turbine. The reason that the capacity factor is much less than large-scale wind is

Submitted by:
NorthWestern Energy
208 N. Montana Ave., Suite 205
Helena, MT 59601
(406) 443-8963

because they are installed closer to the ground (where the wind speeds due to ground friction are less) and the turbines are not as efficient.

As an example, a 10 kW wind turbine located at Stanford (near Judith Gap) has a capacity factor of about 12%. This system produces about 10,500 kWh per year. The installed cost of this system is $45,000 to $50,000. At an average residential retail rate of $0.10/kWh, the simple payback with savings is $45,000/(10,500 x $0.10) or 43 years. Most of the other small-scale turbines that have been metered have capacity factors of 8% or less so the economics are even worse for most areas.

The 10kW wind turbine located on the Bullock soccer fields – behind Wal-Mart in Butte – is mounted on an 80-foot tower (to be in compliance with airport standards) and has a capacity factor from 2% to 3%.

For most areas of Montana located on the east side of the Rocky Mountains, the payback with savings when including utility and tax incentives, and the maintenance costs for a small-scale wind system range from 35 to 45 years. It is questionable whether a wind turbine would last 35 years, so it is unlikely that these systems will pay off.

Medium-Scale Wind –

The installed cost for medium-scale wind is also about $4.50 to $6.00 per watt. However, because the turbine is mounted higher and because the system is more efficient, the capacity factor for medium-scale is higher (ranges from about 15% to 22%) depending again on the location. The City of Great Falls recently installed a 50 kW machine on their county shop at a cost of $300,000. Based on a couple months' worth of data, it appears that this machine will produce about 105,000 kWh/yr. Without utility or tax incentives, the simple payback with savings is over 40 years. Also, note that wind turbines require service and maintenance (mainly lubrication). These costs have not been included.

Comments on Wind –

The power equation for wind is $P=1/2dAV^3$. The V is wind speed cubed – hence the importance of placing the turbine as high as possible into the jet stream. The other part of the equation that is important is the A, or area, since this relates to blade diameter. For example, increasing the blade diameter from 10 feet to 12 feet results in a power gain of about 40% ($A=piD^2/4$). This equation illustrates the exponential increases for going higher and larger. Researchers are now experimenting with wind turbines that would approach 4 MW, which would be placed in the ocean – better economics in large part due to the power relationship discussed.

Bergey Wind, the largest manufacturer of small-scale wind turbines in the U.S., is moving toward larger wind because they feel solar PV is and will continue to displace small-scale wind.